Late Carboniferous floras of Slovenia – a review

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ABSTRACT

The paper is a short review on the Late Carboniferous floras in Slovenia. The Namurian-Westphalian or Westphalian A (Langsettian) flora was collected in the Sava Folds, whereas the Stephanian flora was documented in the Southern Karavanke Mts. The recovered assemblages are well represented by horsetails, arborescent lycopsids, fern-like foliage (ferns and pteridosperms) as well as gymnosperms and they correspond to general features of the Euramerican flora.

Key words: megaflora, Late Carboniferous, Slovenia

1. INTRODUCTION

The post-Variscan Carboniferous and Permian strata with fossil megaflora in Slovenia crop out in the geotectonic units of the Southern Alps and External Dinarides (Figs. 1, 2). In central Slovenia the Upper Palaeozoic, particularly clastic sedimentary rocks, provides a soft bed for the nappe structure of the External Dinarides PLACER (1999). Owing to the complicated tectonic structure, lack of marker horizons and scarce fossil remains the thick monotonous clastic sedimentary sequence underlying the Val Gardena Formation was attributed both to the Carboniferous and Permian. In central Slovenia these strata are represented in the Sava Folds (WINKLER, 1923) that are composed mainly of quartz conglomerate, sandstone, siltstone and shaly claystone.
Occurrences of Palaeozoic flora of the Sava Folds were reported already in the nineteenth century and in the first half of twentieth century by MORLOT (1850), HAUER (1851), LIPOLD (1857, 1858), KOSSMAT (1913), TORNQUIST (1929) and RAKOVEC (1932). Later studies on megaflora of the Sava Folds were published by KOLAR-JURKOVŠEK & JURKOVŠEK (1985, 1986, 1990, 2002a, 2002b, 2007).

Sections of the Upper Carboniferous in the Southern Karavanke Mountains are commonly exposed in narrow belts or scattered outcrops as a result of a strong Alpine tectonics (BUSER, 1980; JURKOVŠEK, 1987). The composite Carboniferous and Permian lithostratigraphical column can be well correlated with the standard zonation in the Carnic Alps that is formed of the Pontebba Supergroup (Auernig Formation, Rattendorf Group and Trogkofel Group) (NOVAK, 2007). Upper Carboniferous megaflora from the Southern Karavanke mountains was reported by MORLOT (1850), STUR (1886) and RAMOVŠ (1978).

2. GEOLOGICAL SETTINGS AND PALEONTOLOGICAL REMARKS

2.1. Sava Folds

In the wider region of the Sava Folds, the Paleozoic strata of the Trojane and Litija anticline form the basement of the shallow water (platform) carbonates of the External Dinarides. The basic lithologic members are quartz conglomerate, quartz sandstone, siltstone and mudstone. On the ground of all previous knowledge and his own detailed investigations, MLAKAR (1987, 1994) presented his contribution to the understanding of the Sava Folds geologic structure. He proposed the subdivision of the Paleozoic sequence into three superpositional
units of the first order (Ca, Cb and Cc) that could represent three formations, or three
members of the same formation.

The second superposition unit (Cb) was subdivided into four units. The Cb2 subunit has been
dated on palaeontological data and attributed a Namurian – Westphalian A age, at present
Namurian-Langsettian age (KOLAR-JURKOVŠEK & JURKOVŠEK, 1985, 1986, 1990,
2002a, 2002b, 2007). The megafloa was collected in numerous localities between Ljubljana
and Polšnik near Litija (Figs. 3, 4) and it is well-represented by horsetails (Calamites),
arborescent lycopsids (Lepidodendron, Sigillaria, Stigmaria), fern-like foliage (ferns and
pteridosperms), and gymnosperms (Cordaites).

The westernmost locality of Sava Folds is at Ljubljana Castle Hill and the age of the
recovered plant assemblage from Castle Hill is based on the species Neuropteris tenuifolia
SCHLOTHEIM, N. cf. heterophylla BRONGNIART and Cordaites palmaeformis
(GOEPPERT) as well as presence of certain mesocalamite-like forms (Calamites
(Mesocalamites) roemer GOEPPERT, C. (M.) cf. cistiiiformis STUR) (Fig. 5). Therefore the
strata with flora from this locality are attributed to the lower part of the Westphalian A
(Langsettian Substage) (KOLAR-JURKOVŠEK & JURKOVŠEK, 2007).

2.2. Southern Karavanke Mts

Late Paleozoic beds in the Southern Karavanke Mountains are commonly exposed in a
narrow bands or scattered outcrops as a result of a strong overprint by Alpine tectonics.
However, the composite litostratigraphic column display a very similar succession compared
to the Pontebba Supergroup (Auernig Formation, Rattendorf Group and Trogkofel Group) in
the Carnic Alps, which are morphological and orographic continuation of the Southern
Karavanke Mountains (KAHLER, 1985; SCHÖNLAUB, 1985; KRAINER, 1993; NOVAK
& SKABERNE, 2009).
The Upper Carboniferous rocks of the western Karavanke Mountain were described as Javornik beds based on fusulinid foraminifera, and subdivided into the Gzhelian and Orenburghian stages (KOCHANSKY-DEVIDE & RAMOVŠ, 1966; RAMOVŠ & KOCHANSKY-DEVIDE, 1979). Later on, NOVAK (2007) considered Javornik beds an equivalent of Auernig Beds, and he presented a new lithostratigraphic subdivision with Kasimovian (Protriticites) beds in their lowermost part. In general Auernig Beds consist of conglomerates, sandstones and shales with lenses of limestones containing fusulinid and conodont faunas. Fossil megaflora was collected mostly in the Gzhelian beds of the Javornik beds in the area north from Jesenice, and the determined list includes *Polymorphopteris polymorpha* (BRONGNIART) and *Annularia stellata* (SCHLOTHEIM) (Fig. 6), as well as *Lepidodendron cf. scutatum* LESQUEREUX and *Sigillaria brardi* BRONGNIART as reported by RAMOVŠ (1978).

A small flora from the locality Planina under the Golica Mt. was studied but not illustrated by TAKŠIĆ (1947) and following species were determined: *Pecopteris aff. arborescens* BROGNIART, *Alethopteris serlii* BRONGNIART, *Alethopteris grandini* BRONGNIART, *Neuropteris ovata* HOFFMANN, *Neuropteris* sp., *Sphenophyllum* sp., *Annularia stellata* (SCHLOTHEIM) WOOD, *Calamites rimosus* ARTIS, *Calamites* sp. and *Lepododendron rimosum* STERNBERG. TAKŠIĆ (1947) compared this flora with the flora from certain locations in Austria and ranged it in the highest Westphalian D or Lower Stephanian.

3. CONCLUSIONS
Upper Paleozoic deposits, exposed in a broad belt between Ljubljana and Polšnik, have been
the object of detailed paleontologic, sedimentologic, and structural studies for many years.
They were the basis for various, and often conflicting interpretations of accurate age,
depositional environment, and structure of the so-called Permo-Carboniferous beds of the
Sava Folds. The recovered assemblages which were collected during the last decades in the
second superposition member (Cb2) can be considered as the hydrophile to hygrophile flora
that populated wet habitats of the swamp area. A large proportion of pteridosperms and
presence of cordaites suggest the growth on somewhat elevated part of river bank, at a margin
of the flood area, as indicated by abundant presence of articulates.
The age of determined assemblages can be estimated based on stratigraphic ranges of certain
species that range in the Westphalian only, however some of them already appear in the
Namurian (KOLAR-JURKOVIČEK, JURKOVIČEK, 2002a).
The fossil flora of the Karavanke Mts. occurs in the Javornik beds which indicates a great
similarity with flora of the Auernig Beds of the Pontebba Supergroup. A well preserved
megaflora was collected in some locations in the area north from Jesenice. However, most
assemblages have not been part of detail study. The megaflora is abundantly represented in
the Upper Carboniferous strata and the recognized assemblages are similar to the late
Westphalian and/or early Stephanian floras of the Carnian Alps.
The recovered plant assemblages from the localities of the Sava Folds and Southern
Karavanke mountains are similar to the fossil flora from other Upper Carboniferous localities
and correspond in their general features to the Euramerican flora (Fig. 7, Tab. 1).
ACKNOWLEDGEMENTS

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REFERENCES


Figure 1: Geologic sketch map of Slovenia with indication of areas with Late Carboniferous flora; A – Southern Alps, B – Sava Folds.

Figure 2: Distribution of tectonic plates in Late Carboniferous. Red dot indicates paleogeographic position of Slovenia on the world map (SCOTESE, C. R., 2002).

Figure 3: One of the richest localities of Carboniferous plant fossils in the Sava Folds at Završnik near Litija. The fossiliferous bed is marked with the geologic hammer (KOLAR-JURKOVŠEK & JURKOVŠEK, 2002a). Photo Bogdan Jurkovšek.

Figure 4: Plant fossils from Ljubljana environs (locality Bizovik). a – Pecopteris sp., specimen height 5,5 cm; b – Lepidodendron cf. aculeatum STERNBERG, specimen height 4 cm. Photo Bogdan Jurkovšek.

Figure 5: Fossil flora from Ljubljana Castle Hill: a - Calamites (Mesocalamites) roemeri GOEPPERT, b - Calamites (Mesocalamites) cf. cistiformis STUR, c - Calamites sp., d -
Cyperites bicarinatus LINDLEY & HUTTON, e - Neuropteris tenuifolia SCHLOTHEIM.

Photo Bogdan Jurkovšek.

Figure 6: Upper Carboniferous fossil plants Polymorphopteris polymorpha (BRONGNIART) and Annularia stellata (SCHLOTHEIM). Planina pod Golico, Karavanke Mts. Sample width 14 cm. Photo Jože Bedič.

Figure 7: Reconstruction of Upper Carboniferous landscape based on fossils collected in Slovenia (by BARBARA JURKOVSÉK, 2006).

Table 1: Comparison of Late Carboniferous flora in the investigated localities of the Sava Folds (KOLAR-JURKOVSÉK & JURKOVSÉK, 2007).
Figure 2.

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